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RED SALMON SPAWNING GROUND SURVEYS IN THE NUSHAGAK AND TOGIAK DISTRICTS, BRISTOL BAY, 1963

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INTRODUCTION

In 1963 the Alaska Department of Fish and Game conducted intensive aerial surveys of red salmon spawning grounds in the Nushagak and Togiak districts of Bristol Bay. This was the fourth consecutive year the Department has been responsible for the spawning ground distribution estimates. The program was initiated in 1946 by the Fisheries Research Institute and continued through 1959 by that agency.

The purpose of this survey program is to provide accurate estimates of abundance and distribution of red salmon in the various spawning areas. Results obtained are essential to both research and management for optimum escapement studies and the attainment of escapement goals. The distribution of fish on the spawning grounds in the past few years has become an important factor in the determination of escapement levels for the Nushagak and Togiak districts.

Seven spawning systems are included in the surveys: Wood River, Igushik, Nunavaugaluk, Tikchik, Nushagak-Mulchatna, Togiak and Kulukak. These areas are shown in Figures 1 through 6.

METHODS

Survey Methods

The total escapement to the Wood River, Igushik, Tikchik and Togiak Lakes and Lake Nunavaugaluk were estimated by the tower counting method. Escapements to the Nushagak-Mulchatna and Kulukak River systems and tributaries of the Togiak River were estimated by aerial surveys.

A Cessna 180 floatplane was used for all aerial surveys. Numbers and location of fish were entered on large scale maps (1 inch = 2 miles) of the spawning systems. Estimates of the number of spawners were made in convenient units of 100's or 1,000's and tallied on a hand counter while flying over the spawning grounds. Surveys were timed to coincide with the peak spawning periods in each area. Preliminary surveys were often made of later spawning areas while enroute to areas of earlier spawning.

Aerial survey estimates for the year 1960-1962 were made by Wilbur A. Church, with Jay Stovall as pilot. The author participated in part of the survey in 1962, and conducted the 1963 survey with Stovall continuing as pilot;

therefore, it was possible to maintain a reasonable continuity of method following the untimely death of Wilbur A. Church in July of 1963.

Supplemental ground surveys were made by personnel from the Fisheries Research Institute and the Alaska Department of Fish and Game. These ground counts provided a valuable comparison with aerial estimates, especially for areas where spawning density was very heavy.

Chain-Link Method [1]

The chain-link method is a process by which total spawning populations can be assigned to the various spawning area in a river or lake system. The chain-link method makes use of the ratios of peak aerial spawning ground estimates by comparing the estimates from any one year with the succeeding year. This method which weights the known total escapement as obtained by tower counts, produces estimates of the total population in each of the major spawning areas.

In order to obtain a basis for comparison of the spawning population in each area from year to year, an independent total population estimate of the different areas of the Nushagak district was made. The year 1956 was chosen as the base year because the total escapement to the system in that year was nearest to the mean value of known red salmon escapements.

Peak aerial spawning estimates from year to year were then used in comparing the abundance of spawners from one year to the next. By relating the base year, 1956, to the adjacent years by means of a chain-link of survey indices, the total population estimates for each succeeding year were obtained from the peak spawning ground surveys.

The chain-link method has been used to determine the total population estimates for the following two reasons:

1. The year by year comparison was considered to be more sound than resorting to making an entirely independent series of estimates for each major spawning area each year.

2. The method now in use can be carried backward to prior years when survey data were available, but were not calculated as total population estimates.

Advantages of the chain-link method are:

1. The chain-link method allows data taken by different methods or observers to be incorporated into the index method.

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[1] A more comprehensive coverage of this method may be found in "Red Salmon Spawning Ground Survey in the Nushagak District, Bristol Bay, 1946-1958" by John Gilbert, Fisheries Research Institute, University of Washington.

2. The chain-link method permits the inclusion of newly discovered or newly surveyed spawning areas into the index series.

3. The chain-link may be considered the most reliable method of treating the data by comparing adjacent years when there is a change of personnel and methods or both.

Some insight into the reliability and accuracy of the chain-link method can be gained by comparing the total population estimates before revision with the tower enumeration figures. The sum of the major spawning unit population estimate in the Wood River system (Table 7) has only varied from 1.5 percent to 7.3 percent (average 4.3 percent) difference from the known total population during the years 1959-1963 when the aerial survey program was conducted by three different observers.

Two experiments conducted in 1961 gave further insight into the dependability of the chain-link method. In 1961 the total number of spawners entering two control areas were estimated by the tower count tag-recovery method, with the results of the experiment being held in secrecy. The spawning ground surveys were carried out in the usual manner and the population of the two control areas was estimated using the chain-link method. Comparison of the estimates based on spawning ground survey and the tagging-tower enumeration were remarkably close as shown below:

Control Area	Survey Estimate	Tower Enumeration-Tagging
Little Togiak Lake	11,000	10,497
Lake Kulik	19,400	20,785 - 22,626

The above findings indicated that reasonable and usable results may be achieved in most cases by the use of the chain-link method.

In applying this technique to the 1963 data, peak spawning estimates from all areas within a given lake or river system were added together. The 1963 data was then compared with similar estimates made in 1962 and the 1963-1962 ratio was obtained by dividing the 1963 aerial estimate by the 1962 estimate (Tables 1-4). The 1963 ratio was then multiplied by the 1962 total population estimates which give the 1963 preliminary population estimates for each lake and river within the systems (Table 5 and 6). The preliminary population estimates were then revised to agree with tower counts by distributing the difference among all areas. In carrying out this revision, all available data from the surveys were used in producing total population estimates which were considered to be most realistic. Information gathered which had a bearing on this revision included: (1) the duration of spawning in various areas, (2) the timing and coverage of the surveys, (3) the factors affecting the reliability of the survey, and (4) the personal impressions of the author as to the reasonableness of the estimate.

In areas where tower counts are not available, the chain-link method is used to determine the estimate of the total spawning population.

NUSHAGAK DISTRICT

Wood River Lakes

Peak aerial estimates for the Wood River Lakes in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 1. Preliminary population estimates and estimates adjusted to the tower count total are shown in Table 5.

The 1963 escapement of 721,400 red salmon to the Wood River Lakes was 83 percent of the 1962 escapement and constituted 67.8 percent of the known Nushagak district escapement (Table 5).

Three areas accounted for over 75 percent of the spawning: Lakes Kulik, Beverly and Nerka. Most noteworthy was the very large return to Lake Kulik which received 15.4 percent of the Wood River Lakes escapement. The 1963 return to Lake Kulik was the largest since 1959, and is considerably above the four-year average for that area (Table 7). Over 80 percent of the spawning in Lake Kulik took place on the north shore beaches.

Lake Beverly accounted for over 34 percent of the Wood River Lakes escapement, which is also higher than the 1959-1963 average (Table 7). Silver Horn, Hardluck Bay and B-12 Beach were the most important spawning areas in Lake Beverly. Moose Creek, Hope Creek and B-9 Beach had far fewer spawners than those areas are capable of supporting.

Lake Nerka received about 25 percent of the escapement, which is lower than the 36 percent average for the past four years. Creek spawning in Lake Nerka was generally poor, with a few notable exceptions, namely Fenno Creek, which received its largest escapement since 1959. Beach spawning also declined in Lake Nerka, the main beach spawning contributors being Anvil Bay Ott's Bay and N4-N6 Beach all of which were below the 1962 population levels (Table 1).

Lake Aleknagik contributed only 2 percent of Wood River Lakes escapement, one of the lowest returns on record. Only Hansen, Ice and Bear Creeks, and Yako Beach received fair numbers of spawners.

Spawning in the rivers between lakes accounted for about 20 percent of the escapement to the Wood River Lakes. Only Wood, Agulowak, and Wind Rivers failed to show an increase over the 1962 populations. The Agulukpak, Little Togiak, Peace and Grant Rivers all showed an increase in spawners over 1962.

Distribution of spawners in the three major types of spawning areas, creeks, beaches, and rivers, is shown in Table 11. The 1963 percentage distribution of spawners by area compares favorably with the five-year average (Table 11).

Large returns to the Agulukpak, Peace and Grant Rivers, and the small returns to the spawning creeks throughout the lake system resulted in an increase

in percent of river spawning and a decline in percent of creek spawning over 1962.

The percent of fish accounted for by peak aerial estimates is derived by dividing the sum of the peak survey estimates by the total escapement obtained from tower counts. The percent of total escapement accounted for by the peak aerial estimates in the Wood River Lakes in 1963 was 55.3 percent (Tables 9 and 10). This is an increase over the average and is accounted for by the increase in river spawning.

Igushik Lakes

Peak aerial estimates for the Igushik Lakes in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 2. Preliminary and adjusted estimates are shown in Table 5.

The 1963 escapement of 92,200 red salmon to the Igushik Lakes was 5.9 times that of 1962 and constituted 8.7 percent of the known Nushagak district escapement.

As in previous years, the majority of the escapement was contained in Lake Ualik and the Kathlene River, while Lake Amanka supported a minor percentage of the population (Table 7).

In 1963 the majority of the spawning took place in the upper portion of the Kathlene River (Table 2). The west shore of Lake Ualik continued to be the most important spawning area in the lake.

The distribution of spawners in the Igushik Lakes was similar to 1962 except for a large reduction in creek spawning, and an increase in river spawning (Table 11). The beach spawning estimate of 44.8 percent compares closely with the five-year average. Due to the correspondingly large return to the Kathlene River, river spawning accounted for almost 50 percent of the escapement, the highest in the last five years of observations.

The percent of total escapement accounted for by the peak aerial estimates was 47.2 percent, which compares favorably with past years for this area (Table 9).

Lake Nunavaugaluk

Peak aerial estimates for Lake Nunavaugaluk in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 2. Preliminary and adjusted estimates are shown in Table 5.

The 1963 escapement of 38,000 red salmon to Lake Nunavaugaluk was 21.1 times that of 1962 and constituted 3.6 percent of the known Nushagak district escapement. The 1963 escapement to Lake Nunavaugaluk exceeded the sum of estimates for the previous three years (Table 7).

The southwest and west shore beaches and Killian Creek continued to receive the majority of the spawners. Spawning distribution was very light

and scattered in other areas.

Lake Nunavaugaluk has the highest percent of beach spawning in the Nushagak district. Nineteen sixty-three proved to be an exception as 76.1 percent of the escapement were beach spawners (Table 11). Creek spawning was down slightly from 1962. Killian Creek produced over 85 percent of the creek spawning in this lake system.

The percent of total escapement accounted for by peak aerial survey estimates was 45.5 percent (Table 9).

Tikchik Lakes

Peak aerial estimates for the Tikchik Lakes in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 3. Preliminary and adjusted population estimates are shown in Table 5.

The 1963 escapement of 166,600 red salmon to the Tikchik Lakes was 4.4 times that of 1962 and constituted 15.7 percent of the known Nushagak district escapement.

Approximately 50 percent of the Tikchik Lakes escapement spawned in the Tikchik River in 1963. The river connecting Lakes Chauekuktuli and Nuyakuk, received a significant number of spawners for the second straight year (Table 3).

The entire spawning population of Tikchik Lake, 19 percent of the system total, was represented by creek spawning in creeks "A" and "B".

Lake Chauekuktuli received 28 percent of the spawning population, most of it concentrated along the important Allen River Beach area.

Due to the large return to the Tikchik River, the percent of river spawners was double that for 1962. The excellent returns to the two creeks in Tikchik Lake resulted in an increased creek spawning percentage over 1962. The percent of beach spawners was well below the average for the past few years (Table 11).

The high percent of fish accounted for by peak aerial surveys (55.5 percent) was due to the increase in river spawning (Table 9).

Nushagak and Mulchatna Rivers

Peak aerial estimates for the Nushagak and Mulchatna Rivers in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 3. Preliminary and adjusted population estimates are shown in Table 5.

The 1963 escapement estimate of 45,700 red salmon to the Nushagak and Mulchatna Rivers is based solely on aerial surveys. Spawning populations in the Nushagak-Mulchatna system constituted 4.3 percent of the known Nushagak district escapement.

The Nushagak-Mulchatna system showed increases in spawning populations in all of the important spawning areas over 1962 (Table 7).

The Kokwok River system accounted for approximately 65 percent of the total escapement. Nearly the entire population to this river spawned along the beaches of the Okstukuk Lakes, located at the head of the river.

Red salmon were observed in most of the tributaries of the Nushagak River, but were usually in small, widely scattered groups.

The Nushagak-Mulchatna River system has not been listed in Table 11. All three types of spawning areas are represented in this system; however, it is difficult to differentiate between creek and river spawning.

Most of the spawning in the Nushagak, King Salmon, Koktuli and Iowithla Rivers takes place in the rivers themselves. In the Mulchatna River, there is little spawning in the main river. Most of these spawners utilize the many small sloughs and tributaries, and could be classified as creek spawners. In the Kokwok River system, most spawning takes place on the beaches of a few small lakes at the head of the river.

TOGIAK DISTRICT

Togiak Lakes

Peak aerial estimates for the Togiak Lakes in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 4. Preliminary and adjusted population estimates are shown in Table 6.

The 1963 escapement of 102,400 red salmon to the Togiak Lakes was 2.2 times that of 1962, and constituted 80.3 percent of the known Togiak district escapement (Table 6).

The most noteworthy factor of the spawning distribution in the Togiak Lakes, which consists primarily of beach spawning, was the very large return to Upper Togiak Lake. Comparing the 1963 spawning escapement with the 1959-1963 average, it is evident that Upper Togiak Lakes received a large return (Table 8).

Estimated spawning populations of Zwischen River and Jondik Creek were lower than in 1962. Jondik and Makoo Creeks contained the only creek spawning of any consequence.

Beach spawning on the east shore of Togiak Lake was heavy and well distributed. The west shore beach spawning population was the largest observed in the last five years.

The percent of creek and river spawners decreased in 1963 and was below the average (Table 11). Beach spawning showed the highest percent since 1959.

The percent of fish accounted for by peak aerial estimates was 49.9 percent (Table 9).

Togiak Tributaries

Peak aerial estimates for the Togiak tributaries in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 4. Preliminary and adjusted population estimates are shown in Table 6.

The escapement of 13,800 red salmon to the Togiak tributaries estimated by aerial surveys was 95 percent of that of 1962, and constituted 10.8 percent of the known Togiak district escapement (Table 6).

Gechiak Lake, which in previous years supported the great majority of spawners to this system, supported less than half of the tributary spawning escapement total in 1963. Ongivinuk and Gechiak Lakes supported over 80 percent of the tributary total (Table 8).

Of the Togiak tributaries, the Gechiak Lake system supports the greatest percentage of creek spawning. The unnamed spawning creek at its head usually contributes at least half of the Gechiak Lake total. Minor numbers of spawners are supported in smaller creeks and at the head of the Gechiak River, with the remainder spawning along the lake beaches.

Ongivinuk Lake primarily supports beach spawning, but also supports river and creek spawning of minor importance. Pungokepuk Lake population consists almost entirely of beach spawners.

In the miscellaneous category are river spawners in the Narogurum, Kaskaiak, and Gechiak Rivers, and beach spawners in several small unnamed lakes.

Tower counts are not conducted on the Togiak tributaries, consequently for the purpose of obtaining population estimates in the drainages, the 1963-62 ratio of peak spawning ground estimates was used (Table 4). The 1963-62 ratio was then multiplied by the 1962 population estimate to give the 1963 preliminary population estimate (Table 6).

Kulukak River System

Peak aerial estimates for the Kulukak River system in 1962 and 1963, and peak estimate ratios for these two years are shown in Table 4. Preliminary and adjusted population estimates are shown in Table 6.

The escapement of 11,400 red salmon to the Kulukak River system estimated by aerial survey was 1.2 times that of 1962, and constituted 8.9 percent of the known Togiak district escapement.

Spawning in the Kulukak system takes place in the Kulukak River and Lake and the Tithe Creek ponds. As in 1962, the 1963 escapement was almost evenly divided between these two areas.

Tithe Creek received an estimated 6,600 spawners, the highest ever recorded for that system (Table 8). Tithe Creek spawning takes place primarily in the numerous spring-fed ponds which drain into the creek. The 1963 escapement into Tithe Creek should be considered as optimum seeding as all of the available spawning gravel was utilized.

The majority of the Kulukak River spawning takes place on the beaches of Kulukak Lake and in the small creek which empties into it.

Because tower counts are not conducted on the Kulukak River system the percent of fish accounted for by peak aerial estimates is considered to be similar to the Togiak Lakes (Table 9). The same method was used to derive the preliminary population estimate for the Kulukak system, as was employed on the Togiak tributaries.

SUMMARY

1. The Alaska Department of Fish and Game continued aerial surveys of the red salmon spawning grounds in the Nushagak and Togiak districts in 1963.

2. The Wood River Lakes received 67.8 percent of the known Nushagak district escapement.

3. Escapements in the Wood River Lakes were unevenly distributed. Lakes Nerka, Beverly and Kulik received over 75 percent of the total escapement. River spawning in Little Togiak, Peace and Grant Rivers was above average. Escapements were poor in Wood River, Lake Aleknagik and the Agulowak River.

4. The percent of creek spawners was below average in the Wood River Lakes. Peak aerial estimates in the Wood River Lakes accounted for 55.3 percent of the total escapement.

5. The Igushik Lakes received 8.7 percent of the known Nushagak district escapement.

6. Escapement to the Igushik Lakes was below average. Again, as in the past four years, the majority of the spawning took place in Lake Ualik, and the Kathlene and Ongoke Rivers.

7. River spawning in the Igushik system accounted for almost 50 percent of the escapement, while creek spawning was below average. Peak aerial estimates in the Igushik Lakes accounted for 47.2 percent of the total escapement.

8. Escapement to Lake Nunavaugaluk accounted for 3.6 percent of the known Nushagak district escapement. The 1963 escapement exceeded the sum of estimates for the previous three years.

9. The Tikchik Lakes received 15.7 percent of the known Nushagak district escapement. This was the largest escapement to this system since 1958.

10. The majority of the fish in the Tikchik system spawned in the Tikchik River and along the Allen River Beach. The high percent of fish accounted for by the peak aerial survey, 55.5 percent, was made possible by the increase in river spawning.

11. The Nushagak and Mulchatna River system escapement was the highest ever recorded. The Kokwok River system accounted for approximately 65 percent of the total.

12. The Togiak Lakes escapement increased over 1962, and constituted 80.3 percent of the known Togiak district escapement. Upper Togiak Lake received a larger proportion of the escapement than usual.

13. The percent of beach spawners in the Togiak Lakes was the highest since 1959. Creek and river spawning decreased. Peak aerial estimates accounted for 49.9 percent of the total escapement.

14. The escapement to the Togiak tributaries accounted for 10.8 percent of the known Togiak district escapement. Ongivinuk and Gechiak Lakes accounted for over 85 percent of the tributary total.

15. The Kulukak system escapement was slightly higher than in 1962. Tithe Creek ponds had the largest spawning population ever recorded. The 6,600 spawners are considered to be optimum seeding.

TABLE 1. COMPARISON OF PEAK SPAWNING GROUND ESTIMATES IN THE WOOD RIVER LAKES, 1962-1963.

Area	1962 Date	1962 No. Est.	1963 Date	1963 No. Est.	Ratio 1963/1962
		WOOD RIVER LAKES			
Wood River	8/30	1,500	8/13	500	.33
LAKE ALEKNAGIK:					
Mission Creek	8/3	980	8/5	10	
Bear Creek	8/2	1,240	8/3	1,500	
Hansen Creek	8/4	3,860	8/3	2,600	
Happy Creek	8/4	650	8/3	650	
Ice Creek	8/9	2,200	8/10	2,000	
Yako Creek	8/5	1,360	8/3	100	
Sunshine Creek	8/9	1,100	8/10	780	
Whitefish Creek	8/6	880	8/10	350	
Northshore Creeks	8/9	1,400	8/10	50	
Northshore Beaches	8/30	490	8/10	480	
South Shore	8/9	230	8/10	200	
Yako Beach	8/9	1,000	8/3	1,200	
LAKE ALEKNAGIK TOTAL		15,390		9,920	.64
Agulowak River & Lower River Bay	8/30	17,180	8/26	12,500	.73
LAKE NERKA:					
Fenno Creek	8/9	1,000	8/3	5,000	
Upper River Bay, N.W.	8/30	420	8/10	500	
Upper River Bay, S.E.	8/30	6,600	8/3	300	
Allah Creek Beach	8/30	5,400	8/3	1,180	
Ross Creek-Pike Creek	8/9	570	8/3	300	
Pike Creek	8/9	12,000	8/10	2,300	
Stovall Creek & Lake	8/9	2,000	8/10	3,650	
Bear Creek	8/9	1,700	8/10	2,100	
Teal Creek	8/9	1,700	8/3	800	
River Bay-N4 Beach	8/30	100	9/11	200	
N4-N6 Beach	8/30	10,150	9/11	4,600	
Pick Creek Beach	8/30	1,350	9/4	900	
Pick Creek	8/9	12,000	8/10	8,500	
Elva Creek Beach	8/30	1,110	9/4	700	
Elva Creek	8/9	330	8/10	200	
Amakuk Arm	8/30	510	9/4	1,300	
Lynx Creek	8/19	600	8/26	1,000	
Lynx Lake	8/30	4,600	8/26	6,150	
Amakuk Arm-Ott's Bay	8/30	1,330	9/4	150	
Ott's Bay	8/30	5,850	9/4	4,400	
Ott's Bay-Agulukpak R.	8/30	100	9/11	-	
Kema Creek	8/19	8,350	8/20	2,350	

Table 1 (continued)

Area	1962 Date	1962 No. Est.	1963 Date	1963 No. Est.	Ratio 1963/1962
Hidden Lake Creek	8/19	1,160	8/26	1,850	
Anvil Bay	8/30	21,570	9/4	18,000	
Anvil Bay-Elbow Pt.	8/30	1,610	9/4	1,030	
Elbow Pt.-Lynx Creek	8/30	2,900	8/10	200	
Little Togiak River	8/19	3,000	8/10	9,000	
LAKE NERKA TOTAL		108,010		76,660	.71
Little Togiak Lake	8/30	7,660	9/11	18,300	2.39
Agulukpak River	8/30	29,700	8/26	45,000	1.52
LAKE BEVERLY:					
Hardluck Bay	8/30	41,400	9/11	21,500	
Sam's Beach	8/30	1,300	9/4	1,200	
Golden Horn	8/30	3,040	8/20	2,370	
Silver Horn	8/30	79,000	9/4	71,300	
B-12 Beach	8/30	14,000	9/4	14,000	
B-9 Beach	8/30	10,000	9/4	2,000	
Anniversary Bay	8/30	600	8/20	-	
Moose Creek	8/19	11,000	8/20	2,100	
Hope Creek	8/19	7,000	8/20	1,800	
Miscellaneous		400		200	
LAKE BEVERLY TOTAL		167,740		116,470	.69
Peace River	8/19	14,000	8/20	18,200	1.30
Lake Mikchalk	8/30	26,500	9/4	15,850	.60
Wind River	8/30	5,300	8/26	4,500	.85
LAKE KULIK:					
North Shore	8/30	29,830	9/4	43,500	
West End	8/19	750	8/20	3,600	
South Shore	8/30	2,130	9/4	5,900	
LAKE KULIK TOTAL		32,710		53,000	1.62
Grant River	8/19	8,700	8/20	27,900	3.21
WOOD RIVER LAKES TOTAL		434,390		398,800	

TABLE 2. COMPARISON OF PEAK SPAWNING GROUND ESTIMATES IN THE IGUSHIK LAKES AND LAKE NUNAVAUGALUK, 1962-1963.

Area	1962 Date	1962 No. Est.	1963 Date	1963 No. Est.	Ratio 1963/1962
		IGUSHIK LAKES			
Igushik River	8/8	140	8/20	40	.29
LAKE AMANKA:					
Longarm Creek	8/8	430	8/20	100	
Middle Creek	8/8	30	8/20	400	
South Creek	8/8	10	8/20	150	
Amanka Beaches		60	9/7	1,040	
LAKE AMANKA TOTAL		530		1,690	3.19
KATHLENE RIVER:					
Lower River	8/8	1,100	8/20	900	
Upper River	8/8	640	8/20	20,000	
Ongoke River	8/8	1,900	8/20	340	
KATHLENE RIVER TOTAL		3,640		21,240	5.84
LAKE UALIK:					
Frances Creek	8/8	700	8/20	1,330	
West Shore Creeks	8/8	150	8/20	100	
West Shore		2.210	9/7	17,340	
East Shore Creeks	8/8	80	8/20	150	
East Shore		190	8/20	1,610	
LAKE UALIK TOTAL		3,330		20,530	6.17
IGUSHIK LAKES TOTAL		7,640		43,500	
		LAKE NUNAVAUGALUK			
Snake River	8/9	70	8/10	250	
Snake River-Eagle Creek		130	8/10	1,580	
Eagle Creek	8/9	80	8/10	510	
West Shore		40	9/7	9,140	
Killian Creek	8/9	90	8/10	3,750	
East Shore		400	9/7	1,600	
East Creek	8/9	100	8/10	110	
South Shore		10	8/10	340	
LAKE NUNAVAUGALUK TOTAL		920		17,280	18.78

TABLE 3. COMPARISON OF PEAK SPAWNING GROUND ESTIMATES IN THE TIKCHIK LAKES AND NUSHAGAK-MULCHATNA SYSTEM, 1962-1963.

Area	1962 Date	1962 No. Est.	1963 Date	1963 No. Est.	Ratio 1963/1962
		TIKCHIK LAKES			
*Nuyakuk River	8/10	(160)			
TIKCHIK LAKE:					
Creek A	8/10	600	8/18	5,000	
Creek B	8/10	620	8/18	10,000	
Creek C	8/10	10		-	
TIKCHIK LAKE TOTAL		1,230		15,000	12.20
Tikchik River	8/10	1,840	8/4	50,000	27.17
NUYAKUK LAKE:					
North Shore	8/31	420	9/5	320	
South Shore	8/31	600	8/26	300	
Portage Arm			9/5	200	
Mirror Bay	8/31	230	9/5	650	
Rapids	8/10	1,750	8/18	1,500	
NUYAKUK LAKE TOTAL		3,000		2,970	.99
LAKE CHAUEKUKTULI:					
Creek #1	8/10	30	8/18	100	
Allen River Beach	8/31	8,400	8/26	21,000	
Allen River	8/10	390	8/18	200	
North Shore	8/31	670	8/26	2,900	
South Shore	8/31	170	9/5	240	
LAKE CHAUEKUKTULI TOTAL		9,660		24,440	2.53
TIKCHIK LAKES TOTAL		15,730		92,410	
		NUSHAGAK-MULCHATNA SYSTEM			
NUSHAGAK-MULCHATNA:					
Mulchatna River	8/20	1,760	8/27	3,300	1.88
Koktuli River	8/20	1,130	8/27	2,100	1.86
Nushagak River	8/23	310	8/27	1,100	3.55
King Salmon River	8/23	300	8/5	800	2.67
Iowithla River	8/23	210	8/27	1,000	4.76
Kokwok River	8/23	550	8/26	15,000	27.27
NUSHAGAK-MULCHATNA TOTAL		4,260		23,300	

* Additional peak estimates for 1962 are not included in totals used for computing 1963/1962 ratios.

TABLE 4. COMPARISON OF PEAK SPAWNING GROUND ESTIMATES IN THE TOGIAK DISTRICT, 1962-1963.

Area	1962 Date	1962 No. Est.	1963 Date	1963 No. Est.	Ratio 1963/1962
		TOGIAK LAKES			
Togiak River	8/14	150	8/11	200	1.33
TOGIAK LAKE:					
Outlet to Jondik Creek	9/4	250	9/6	970	
Jondik Creek	8/8	1,500	8/11	890	
Jondik Cr. to Bruin Cr.	9/4	1,070	9/6	3,950	
Middle Pt. to Sunday Cr.	9/4	1,860	9/6	7,800	
North Shore	9/4	860	9/6	1,650	
West Shore	9/4	350	9/6	8,600	
West Creek & Lake	8/8	670	9/6	350	
Bruin Creek to Middle Pt.	9/4	910	9/6	3,500	
TOGIAK LAKE TOTAL		7,470		27,710	3.71
Zwischen River	9/4	6,950	9/6	5,560	.80
UPPER TOGIAK LAKE:					
Zwischen R. to Budole Cr.	9/4	2,340	9/6	9,400	
Budole Cr. to Upper Togiak Creek	9/4	2,630	9/6	2,200	
North Shore	9/4	970	9/6	3,700	
Makoo Creek	9/4	100	9/6	600	
Upper Togiak Creek	9/4	100	9/6	120	
West Shore	9/4	190	9/6	1,650	
UPPER TOGIAK LAKE TOTAL		6,330		17,670	2.79
TOGIAK LAKES TOTAL		20,900		51,140	
		TOGIAK TRIBUTARIES			
TOGIAK TRIBUTARIES:					
Gechiak Lake	8/8	5,160	8/11	2,640	.51
Ongivinuk Lake	9/4	900	9/6	2,700	3.00
Pungokepuk Lake	8/8	230	8/11	580	2.52
Miscellaneous		150		180	1.20
TOGIAK TRIBUTARIES TOTAL		6,440		6,100	
		KULUKAK RIVER SYSTEM			
KULUKAK RIVER SYSTEM:					
Kulukak River & Lake	8/8	2,170	8/11	2,150	.99
Tithe Creek	8/8	2,050	8/11	2,900	1.41
KULUKAK TOTAL		4,220		5,050	

TABLE 5. TOTAL POPULATION ESTIMATES OF RED SALMON IN THE NUSHAGAK DISTRICT, 1962-1963.

Area	1962 Total Pop. Adj. Est.	Ratio 1963/1962	1963 Preliminary Estimate	1963 Observed Adj. Est.	Percent of Observed Adj. Total	Percent of Nushagak District Total
Wood River	2,600	.33	850	800	.11	.08
Lake Aleknagik	26,200	.64	16,768	15,700	2.18	1.48
Agulowak River	20,200	.73	14,746	14,200	1.97	1.34
Lake Nerka	266,100	.71	188,931	182,900	25.35	17.19
Little Togiak Lake	9,700	2.39	23,183	21,100	2.93	1.98
Agulukpak River	31,300	1.52	47,576	47,500	6.58	4.47
Lake Beverly	376,000	.69	259,440	251,500	34.86	23.64
Peace River	14,900	1.30	19,370	19,300	2.68	1.81
Lake Mikchalk	35,900	.60	21,540	19,400	2.69	1.82
Wind River	7,600	.85	6,460	5,000	.69	.47
Lake Kulik	71,900	1.62	116,478	111,100	15.40	10.44
Grant River	11,500	3.21	36,915	32,900	4.56	3.09
TOTALS (WOOD R. LAKES)	873,900	.86	752,265	721,400	100.00	67.81
Lake Nunavaugaluk	1,800	18.76	33,768	38,000	100.00	3.57
Igushik River	300	.29	87	80	.09	.01
Lake Amanka	1,100	3.19	3,509	3,510	3.81	.33
Kathlene River	7,600	5.84	44,384	46,100	50.00	4.33
Lake Ualik	6,700	6.17	41,339	42,510	46.10	4.00
TOTALS (IGUSHIK LAKES)	15,700	5.69	89,319	92,200	100.00	8.67
Tikchik Lake	3,100	12.20	37,820	32,500	19.51	3.06
Tikchik River	4,500	27.17	122,265	80,400	48.26	7.56
Lake Nuyakuk	7,500	.99	7,425	6,100	3.66	.57
Lake Chauekuktuli	22,800	2.53	57,684	47,600	28.57	4.47
TOTALS (TIKCHIK LAKES)	37,900	5.94	225,194	166,600	100.00	15.66

TABLE 5. (Continued)

Area	1962 Total Pop. Adj. Est.	Ratio 1963/1962	1963 Preliminary Estimate	1963 Observed Adj. Est.	Percent of Observed Adj. Total	Percent of Nushagak District Total
Mulchatna River	3,500	1.88	6,580	6,600	14.44	.62
Koktuli River	2,300	1.86	4,278	4,300	9.41	.40
Nushagak River	600	3.55	2,130	2,100	4.59	.20
King Salmon River	600	2.67	1,602	800	1.75	.07
Iowithla River	400	4.76	1,904	1,900	4.16	.18
Kokwok River	1,100	27.27	29,997	30,000	65.65	2.82
TOTALS (NUSH.-MUL.R.)	8,500	5.47	46,491	45,700	100.00	4.29
NUSHAGAK DISTRICT TOTALS	937,800	1.22	1,147,037	1,063,900		100.00

TABLE 6. TOTAL POPULATION ESTIMATES OF RED SALMON IN THE TOGIAK DISTRICT, 1962-1963.

Area	1962 Total Pop. Adj. Est.	Ratio 1963/1962	1963 Preliminary Estimate	1963 Observed Adj. Est.	Percent of Observed Adj. Total	Percent of Togiak District Total
Togiak River	400	1.33	532	400	.39	.32
Togiak Lake	17,000	3.71	63,070	55,100	53.81	43.18
Zwischen River	15,700	.80	12,560	11,500	11.23	9.01
Upper Togiak Lake	14,300	2.79	39,897	35,400	34.57	27.74
TOTALS (TOGIAK LAKES)	47,400		116,059	102,400	100.00	80.25
Gechiak Lake	11,600	.51	5,916	5,900	42.75	4.62
Ongivinuk Lake	2,000	3.00	6,000	6,000	43.48	4.70
Pungokepuk Lake	600	2.52	1,512	1,500	10.87	1.18
Miscellaneous	400	1.20	480	400	2.90	.32
TOTALS (TOGIAK TRIB.)	14,600		13,908	13,800	100.00	10.82
Kulukak River & Lake	4,900	.99	4,851	4,800	42.11	3.76
Tithe Creek	4,700	1.41	6,627	6,600	57.89	5.17
TOTALS (KULUKAK SYSTEM)	9,600		11,478	11,400	100.00	8.93
TOGIAK DISTRICT TOTALS	71,600	1.98	141,445	127,600		100.00

TABLE 7. COMPARISON OF TOTAL POPULATION ESTIMATES AND PERCENT OF RED SALMON IN THE NUSHAGAK DISTRICT, 1959-1963

Area	1959		1960		1961		1962		1963		Geo. Ave. % By Area 1959-1963
	Pop. Est.	%	Pop. Est.	%	Pop. Est.	%	Pop. Est.	%	Pop. Est.	%	
Wood River	7,361	.33	3,200	.32	7,300	1.59	2,600	.30	800	.11	.35
Lake Aleknagik	69,437	3.14	35,800	3.52	19,000	4.12	26,200	3.00	15,700	2.18	3.13
Agulowak River	130,521	5.91	46,100	4.54	127,200	27.61	20,200	2.31	14,200	1.97	5.08
Lake Nerka	1,192,633	53.98	523,900	51.56	139,200	30.22	266,100	30.45	182,900	25.35	36.48
Little Togiak Lake	40,931	1.85	16,800	1.65	10,500	2.28	9,700	1.11	21,100	2.93	1.87
Agulukpak River	115,903	5.25	56,500	5.56	101,600	22.05	31,300	3.58	47,500	6.58	6.86
Lake Beverly	389,371	17.62	189,600	18.66	29,100	6.32	376,000	43.02	251,500	34.86	19.86
Peace River	14,796	.67	13,000	1.28	800	.17	14,900	1.70	19,300	2.68	.92
Lake Mikchalk	33,518	1.52	22,100	2.18	3,200	.70	35,900	4.11	19,400	2.69	1.91
Wind River	3,446	.16	800	.08	2,000	.43	7,600	.87	5,000	.69	.32
Lake Kulik	151,946	6.88	79,800	7.85	9,500	2.06	71,900	8.23	111,100	15.40	6.76
Grant River	59,401	2.69	28,400	2.80	11,300	2.45	11,500	1.32	32,900	4.56	2.56
TOTALS	2,209,264	100.00	1,016,000	100.00	460,700	100.00	873,900	100.00	721,400	100.00	
Lake Nunavaugaluk	140,000	100.00	16,600	100.00	4,900	100.00	1,800	100.00	38,000	100.00	
Igushik River	-	-	-	-	-	-	300	1.91	80	.09	.42
Lake Amanka	1/ 53,534	8.31	41,600	8.41	16,100	5.47	1,100	7.01	3,510	3.81	6.34
Kathlene River	1/ 208,583	32.40	138,100	27.91	124,100	42.18	7,600	48.41	46,100	50.00	39.17
Lake Ualik	1/ 381,683	59.29	315,100	63.68	154,000	52.35	6,700	42.67	42,510	46.10	52.12
TOTALS	643,800	100.00	494,800	100.00	294,200	100.00	15,700	100.00	92,200	100.00	
Tikchik Lake	1/ 11,512	23.54	25,200	17.32	6,700	8.40	3,100	8.18	32,500	19.51	14.03
Tikchik River	1/ 18,386	37.60	39,200	26.94	29,700	37.22	4,500	11.87	80,400	48.26	29.24
Lake Nuyakuk	1/ 1,212	2.48	7,000	4.81	8,500	10.65	7,500	19.79	6,100	3.66	6.19
Lake Chauekuktuli	1/ 17,790	36.38	74,100	50.93	34,900	43.73	22,800	60.16	47,600	28.57	42.46
TOTALS	48,900	100.00	145,500	100.00	79,800	100.00	37,900	100.00	166,600	100.00	

TABLE 7. (Continued)

Area	1959 Pop. Est.	1959 %	1960 Pop. Est.	1960 %	1961 Pop. Est.	1961 %	1962 Pop. Est.	1962 %	1963 Pop. Est.	1963 %	Geo. Av. % By Area 1959-1963
Mulchatna River	-	-	-	-	3,800	18.81	3,500	41.18	6,600	14.44	2/ 22.34
Koktuli River	-	-	-	-	3,600	17.82	2,300	27.06	4,300	9.41	2/ 16.52
Nushagak River	-	-	-	-	800	3.96	600	7.06	2,100	4.59	2/ 5.05
King Salmon River	-	-	-	-	9,000	44.56	600	7.06	800	1.75	2/ 8.19
Iowithla River	-	-	-	-	3,000	14.85	400	4.70	1,900	4.16	2/ 6.62
Kokwok River	-	-	-	-	-	-	1,100	12.94	30,000	65.65	2/ 29.11
TOTALS	-	-	-	-	20,000	100.00	8,500	100.00	45,700	100.00	
NUSHAGAK DISTRICT TOTALS	3,041,964		1,672,900		859,600		937,800		1,063,900		

1/ 1959 population estimate was given as a total; breakdown derived by using "percent fish accounted for" and applying this percent, in proportion, to each area.

2/ Average percent, 1961-1963.

TABLE 8. COMPARISON OF TOTAL POPULATION ESTIMATES AND PERCENT OF RED SALMON IN THE TOGIAK DISTRICT, 1959-1963.

Area	1959		1960		1961		1962		1963		Geo. Av. % By Area 1959-1963
	Pop. Est.	%	Pop. Est.	%	Pop. Est.	%	Pop. Est.	%	Pop. Est.	%	
Togiak River	2,570	1.44	2,500	1.53	1,900	1.99	400	.84	400	.39	1.07
Togiak Lake	145,250	81.26	124,100	76.23	73,400	76.86	17,000	35.87	55,100	53.81	61.94
Zwischen River	5,670	3.17	18,900	11.61	11,600	12.15	15,700	33.12	11,500	11.23	11.04
Upper Togiak Lake	25,250	14.13	17,300	10.63	8,600	9.00	14,300	30.17	35,400	34.57	16.94
TOTALS	178,740	100.00	162,800	100.00	95,500	100.00	47,400	100.00	102,400	100.00	
Gechiak Lake	20,000	64.73	18,900	64.73	16,800	62.69	11,600	79.45	5,900	42.75	61.66
Ongivinuk Lake	8,400	27.18	7,900	27.05	8,400	31.34	2,000	13.70	6,000	43.48	26.73
Pungokepuk Lake	2,500	8.09	2,400	8.22	900	3.36	600	4.11	1,500	10.87	6.30
Miscellaneous	-	-	-	-	700	2.61	400	2.74	400	2.90	2.75
TOTALS	30,900	100.00	29,200	100.00	26,800	100.00	14,600	100.00	13,800	100.00	
Kulukak River & Lake	-	-	-	-	1,000	19.23	4,900	51.04	4,800	42.11	34.51
Tithe Creek	-	-	-	-	4,200	80.77	4,700	48.96	6,600	57.89	61.09
TOTALS	-	-	-	-	5,200	100.00	9,600	100.00	11,400	100.00	
TOGIAK DISTRICT TOTALS	209,640		192,000		127,400		71,600		127,600		

TABLE 9. COMPARISON OF TOTAL POPULATION WITH SUM OF PEAK SURVEY ESTIMATES IN THE NUSHAGAK AND TOGIAK DISTRICTS, 1963.

Area	Total Pop. Est. by Tower Counts	Sum of Peak Survey Estimates	Percent Acct. for by Peak Est.
Wood River Lakes	721,400	398,800	55.28
Lake Nunavaugaluk	38,000	17,280	45.47
Igushik Lakes	92,200	43,500	47.18
Tikchik Lakes	166,600	92,410	55.47
Togiak Lakes	102,400	51,140	49.94
TOTAL	1,120,600	603,130	53.82

TABLE 10. COMPARISON OF TOTAL POPULATION WITH SUM OF PEAK SURVEY ESTIMATES IN THE WOOD RIVER LAKES, 1953-1963.

Year	Total Pop. Est. by Tower Counts	Sum of Peak Survey Estimates	Percent Acct. for by Peak Est.
1953	515,500	155,100	30.09
1954	570,600	138,000	24.19
1955	1,382,800	517,900	37.45
1956	773,100	298,100	38.56
1957	288,700	152,100	52.68
1958	960,500	442,100	46.03
1959	2,209,300	1,028,100	46.54
1960	1,016,100	481,540	47.39
1961	460,700	292,970	63.59
1962	873,900	434,390	49.71
1963	721,400	398,800	55.28
		Average Percent [1]	51.60

[1] Average percent includes only years 1957 through 1963. Increase in the percentage of peak estimates beginning in 1957 is accounted for by an increase in areas covered by aerial surveys.

TABLE 11. PERCENTAGE DISTRIBUTION OF SPAWNERS IN THREE MAJOR TYPES OF SPAWNING AREAS IN THE NUSHAGAK AND TOGIAK DISTRICTS, 1959-1963.

Year	Spawning			Total Pop. Est. by Tower Counts
	Creek	Beaches	Rivers	
		WOOD RIVER LAKES[1]		
1959	32.75	50.30	16.95	2,209,300
1960	27.37	55.50	17.13	1,016,100
1961	11.43	32.31	56.26	460,700
1962	23.97	65.23	10.80	873,900
1963	12.15	68.48	19.37	721,400
AVERAGE	19.68	52.60	20.23	1,056,300
		IGUSHIK LAKES[2]		
1959	34.30	48.20	17.50	643,800
1960	35.50	52.90	11.60	494,800
1961	39.34	34.54	26.12	294,300
1962	43.40	31.55	25.05	15,700
1963	6.21	44.81	48.98	92,200
AVERAGE	26.42	41.59	23.01	308,200
		LAKE NUNAVAUGALUK		
1959	41.70	57.60	0.70	140,000[3]
1960	44.30	50.70	5.00	16,600
1961	24.12	71.99	3.89	4,900
1962	29.35	63.04	7.61	1,800
1963	22.69	76.13	1.18	38,000
AVERAGE	31.19	63.24	2.61	40,300
		TIKCHIK LAKES[4]		
1959	24.10	37.90	38.00	48,900
1960	19.40	53.10	27.50	145,500
1961	11.19	49.63	39.18	79,800
1962	9.49	64.66	25.85	37,900
1963	19.69	29.95	50.36	166,600
AVERAGE	15.74	45.39	35.08	95,700

TABLE 11. (Continued)

Year	Spawning Creek	Spawning Beaches	Spawning Rivers	Total Pop. Est. by Tower Counts
		TOGIAK LAKES[5]		
1959	12.80	82.59	4.61	178,700[3]
1960	12.30	74.56	13.14	162,800
1961	15.89	69.97	14.14	95,500
1962	11.39	54.64	33.97	47,400
1963	4.35	84.03	11.62	102,400
AVERAGE	10.40	72.28	12.74	117,400
TOTAL	19.23	53.83	15.35	

[1] River spawning category from 1959 through 1963 includes Little Togiak and Grant Rivers.

[2] Ongoke River population included in creek spawning category.

[3] Aerial survey estimates.

[4] Rapids between Nuyakuk Lake and Lake Chauekuktuli is included in river spawning category.

[5] River spawning categories from 1959 through 1961 reclassified to conform with method used in 1962-63.

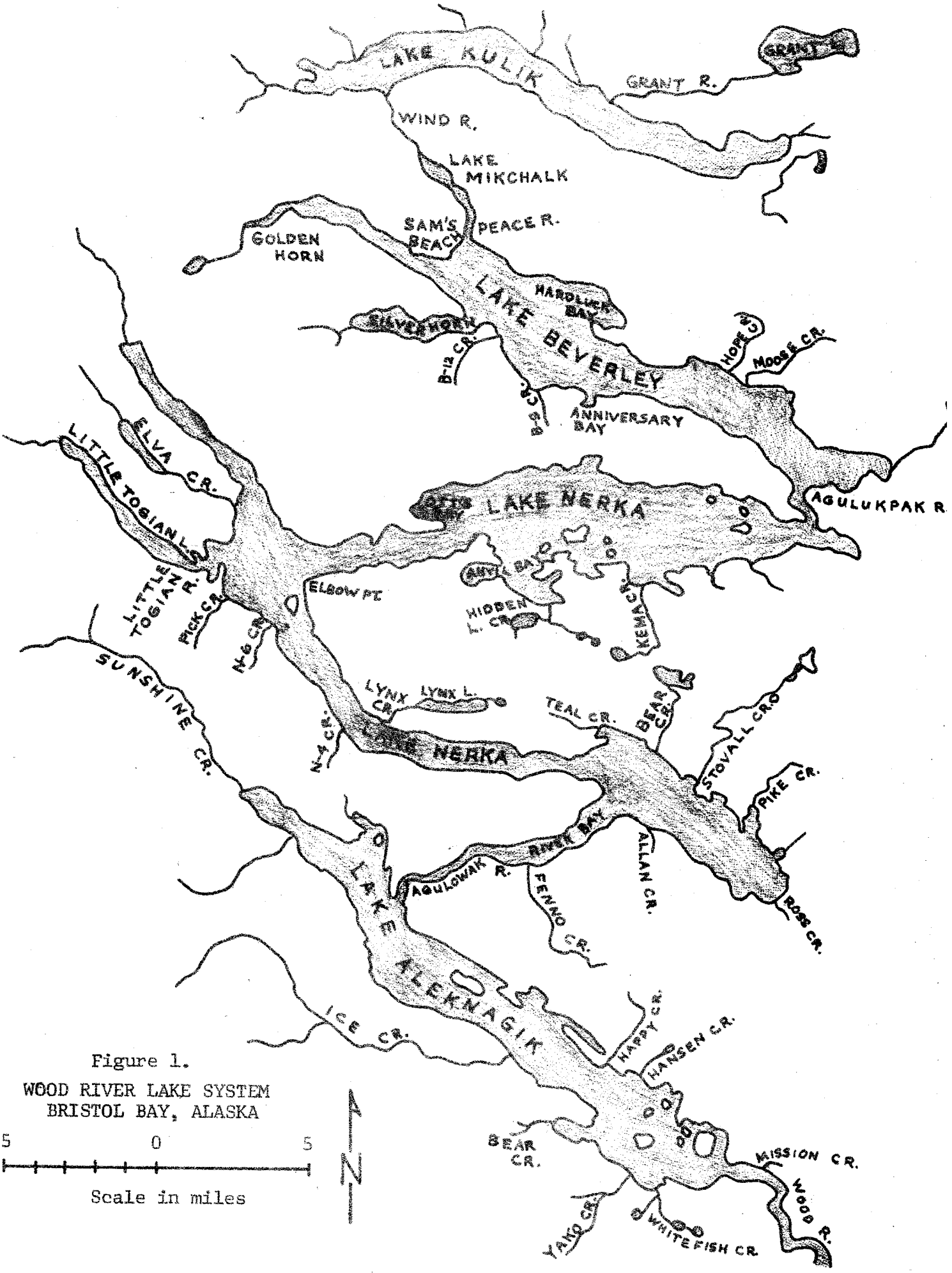


Figure 1.

WOOD RIVER LAKE SYSTEM
BRISTOL BAY, ALASKA

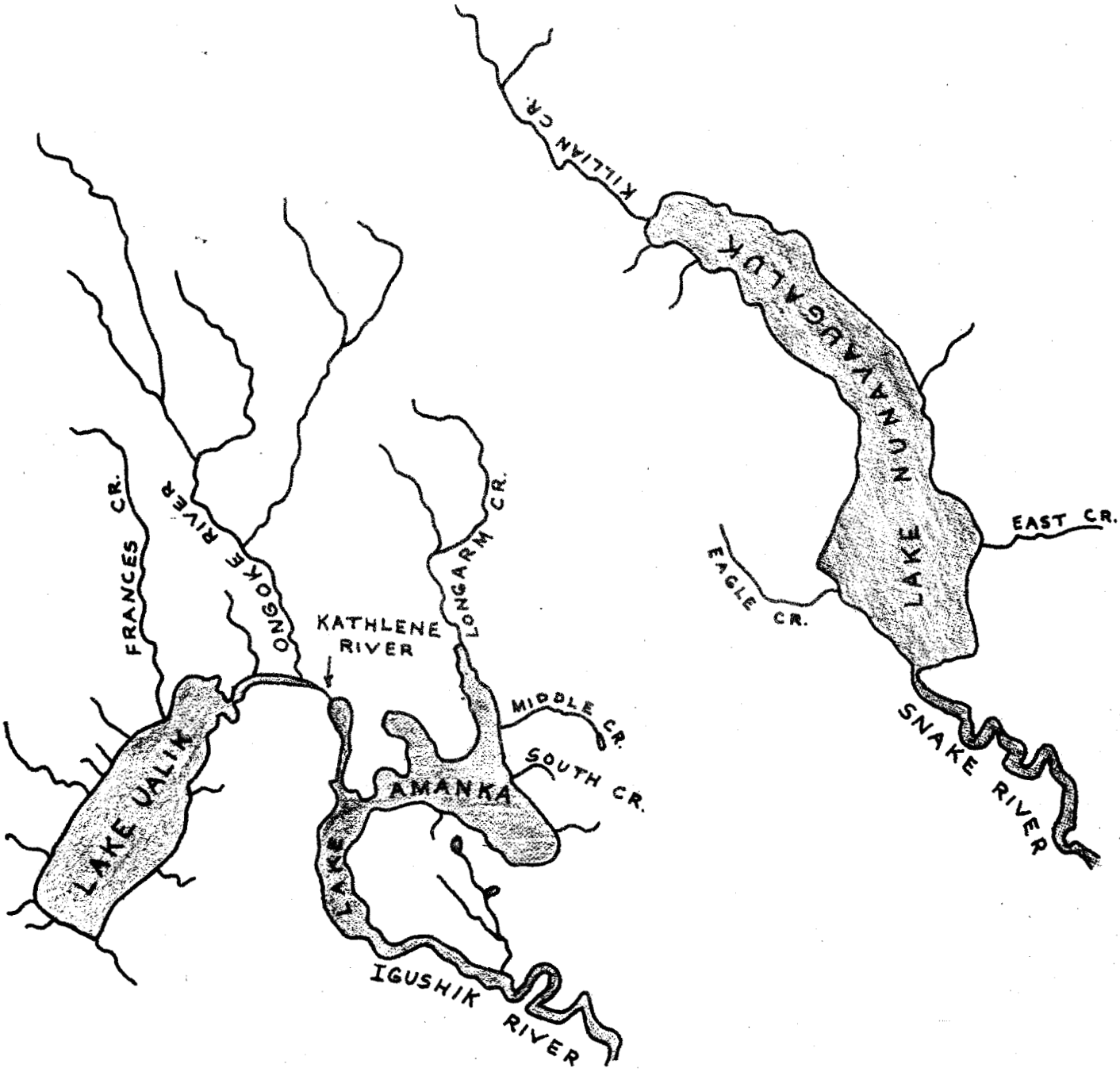


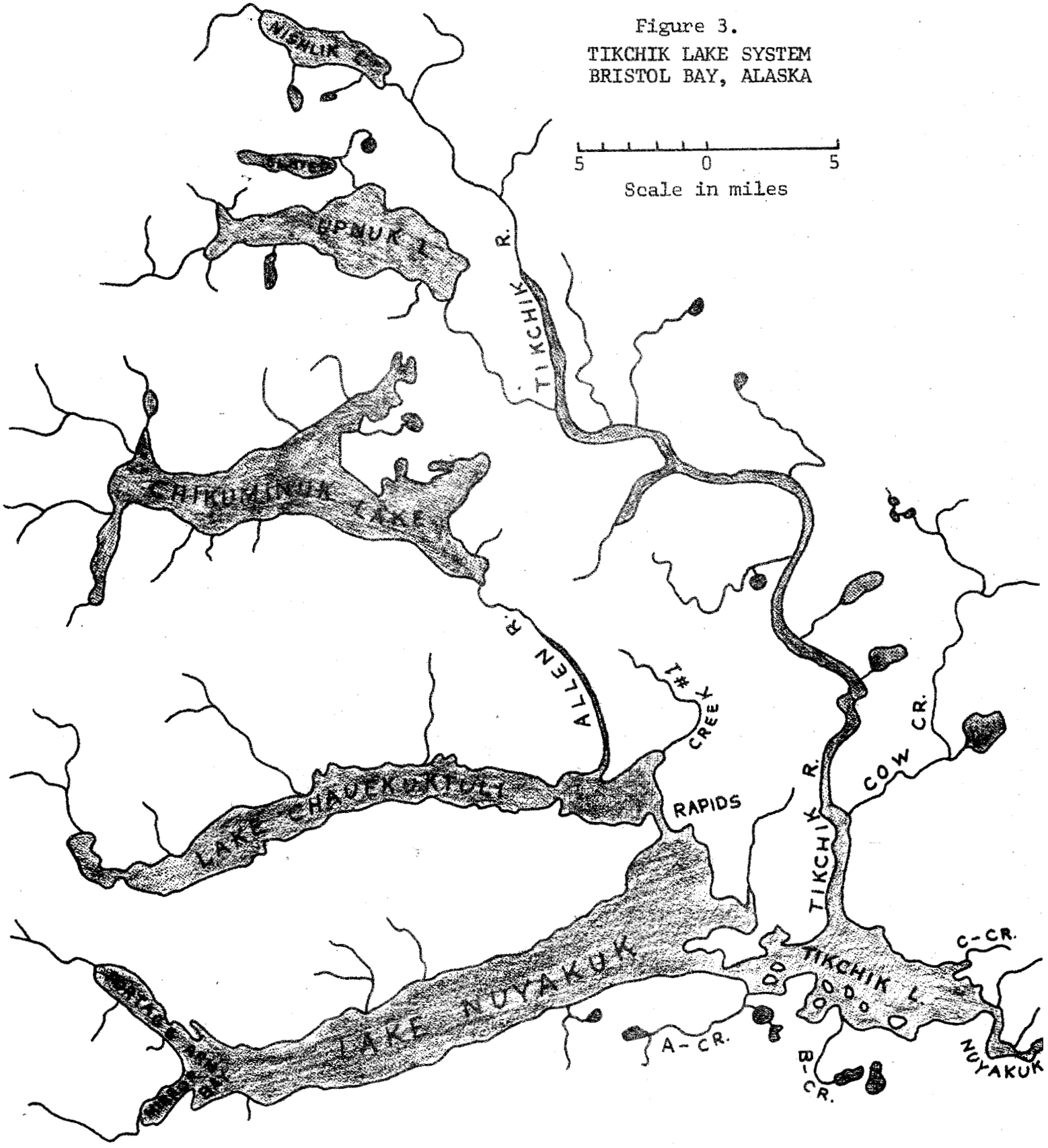
Figure 2.

IGUSHIK AND NUNAVAUGALUK LAKE SYSTEMS
BRISTOL BAY, ALASKA

5 0 5

Scale in miles

Figure 3.
TIKCHIK LAKE SYSTEM
BRISTOL BAY, ALASKA



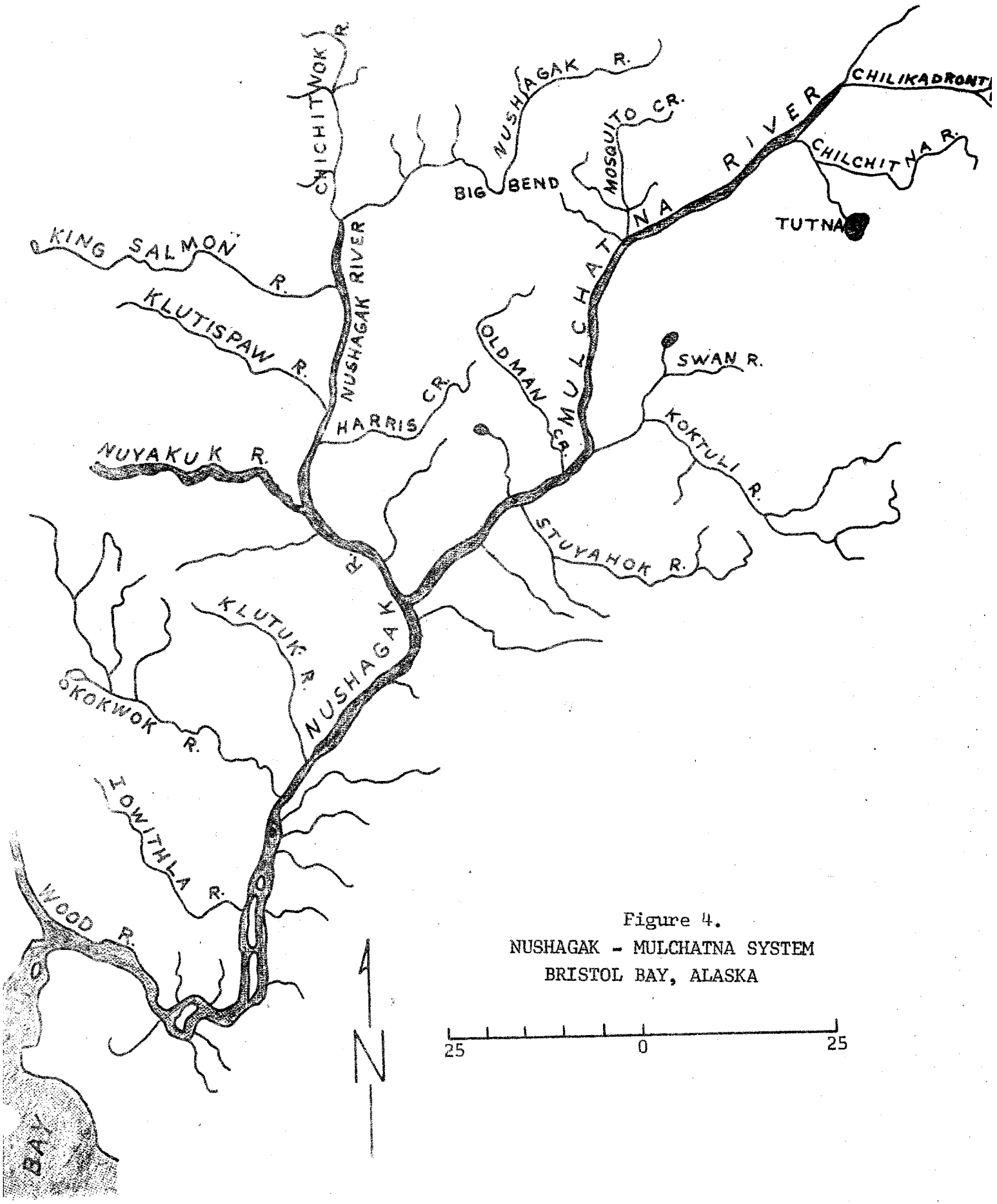


Figure 4.
NUSHAGAK - MULCHATNA SYSTEM
BRISTOL BAY, ALASKA

Figure 5.

TOGIAK RIVER SYSTEM
BRISTOL BAY, ALASKA

5 0 5

Scale in miles

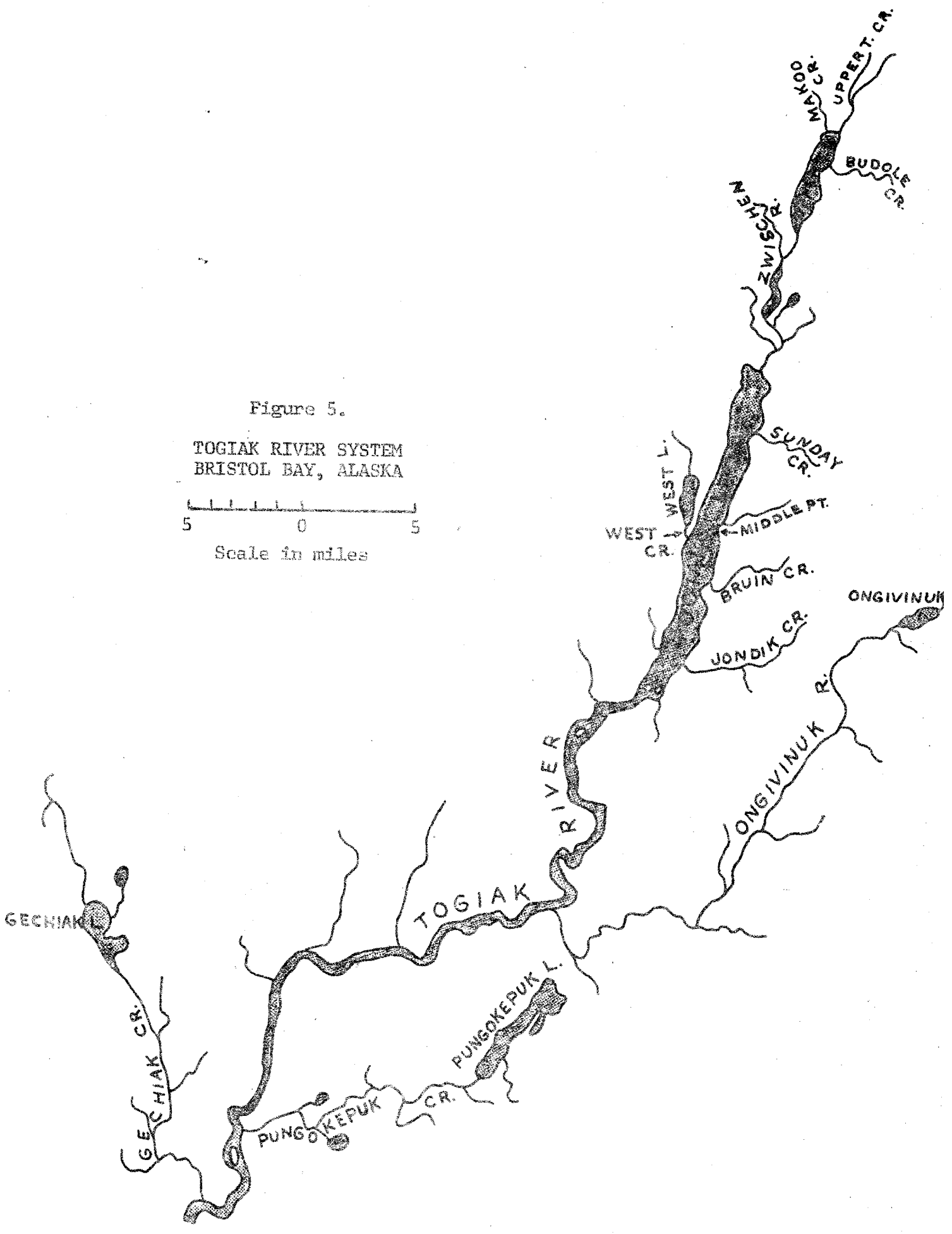


Figure 6.

KULUKAK SYSTEM
BRISTOL BAY, ALASKA